IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

<Name>
<Date>

Outline

- Executive Summary
- Introduction
- Methodology
- Results
- Conclusion
- Appendix

Executive Summary

Summary of methodologies

- • Data collection
- • Data Wrangling
- • EDA with Visualization and SQL
- • Interactive map with Folium
- • Interactive Dashboard with Plotly Dash
- • Predictive analysis using Classification Models
- • Summary of all results
- • EDA Results
- • Interactive Visualization and Dashboard Results
- • Predictive Analysis results

Introduction

- Project background and context

In this project, we will predict if the Falcon 9 first stage will land successfully. SpaceX advertises Falcon 9 rocket launches on its website with a cost of 62 million dollars; other providers cost upward of 165 million dollars each, much of the savings is because SpaceX can reuse the first stage. Therefore if we can determine if the first stage will land, we can determine the cost of a launch.

- Problems you want to find answers

The problems I want to find the answer is to determine if the first stage will land, we can determine the cost of a launch. Therefore if we can determine if the first stage will land, we can determine the cost of a launch. This information can be used if an alternate company wants to bid against SpaceX for a rocket launch.

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:
- Collecting data from SpaceX API
- Web scraping from Wikipedia (Optional)
- Perform data wrangling
- Determining the training labels with one hot encoding and dealing with NULL values
- Perform exploratory data analysis (EDA) using visualization and SQL
- Perform interactive visual analytics using Folium and Plotly Dash
- Perform predictive analysis using classification models
- 4 different models (LR, SVM, KNN and Tree) are used and evaluated for the best results

Data Collection

- Describe how data sets were collected.

Method 1 : Space X REST API

Requesting rocket dzta from SpaceX API using URL.

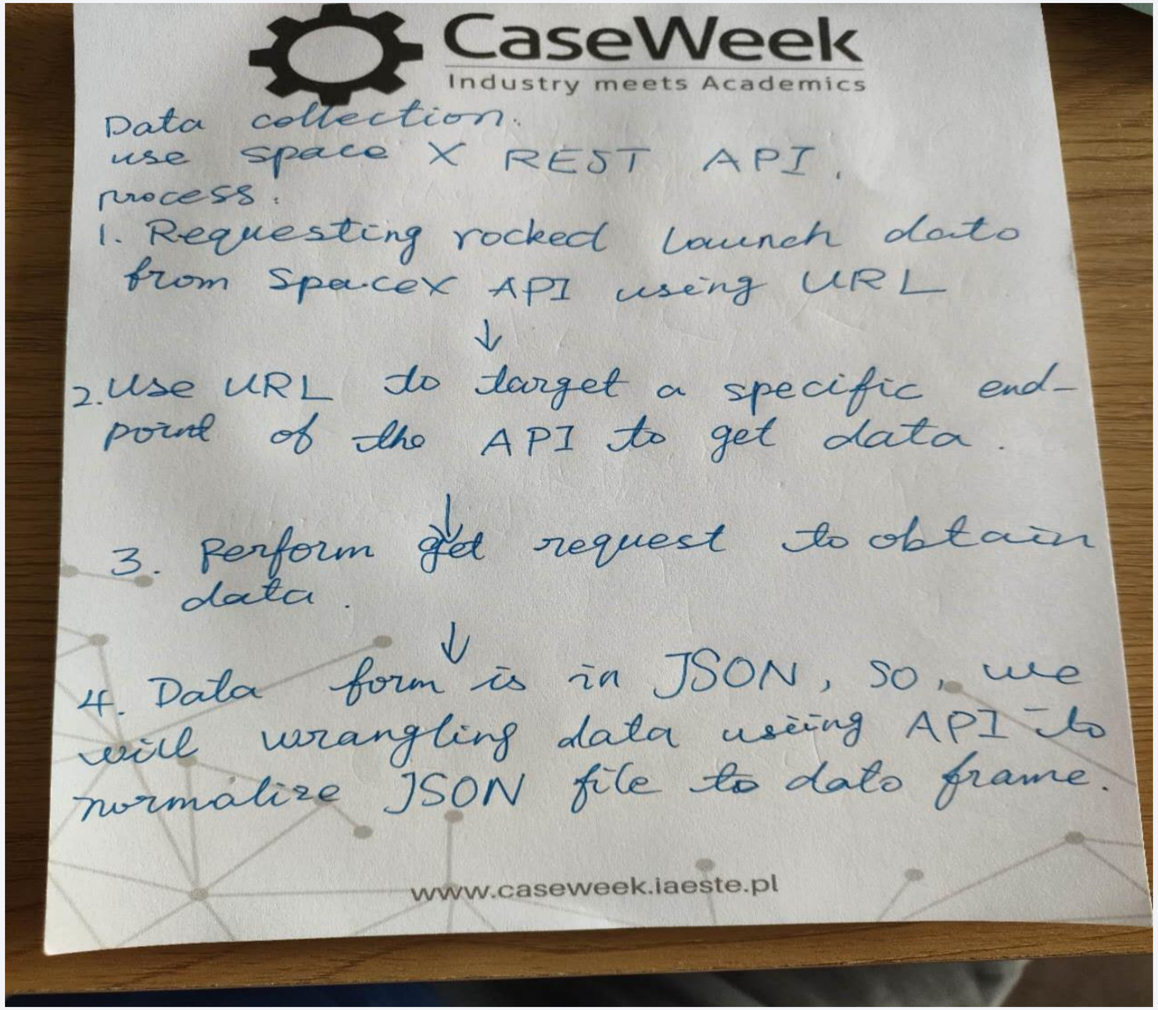
Method 2: Scraping data from Wikipedia

Data Collection – SpaceX API

- General flowchart is shown as right figure.

- The GitHub URL of the completed SpaceX API calls notebook:

https://github.com/Urysohnish/Data-Science/blob/main/final_pro_data_collecting.ipynb

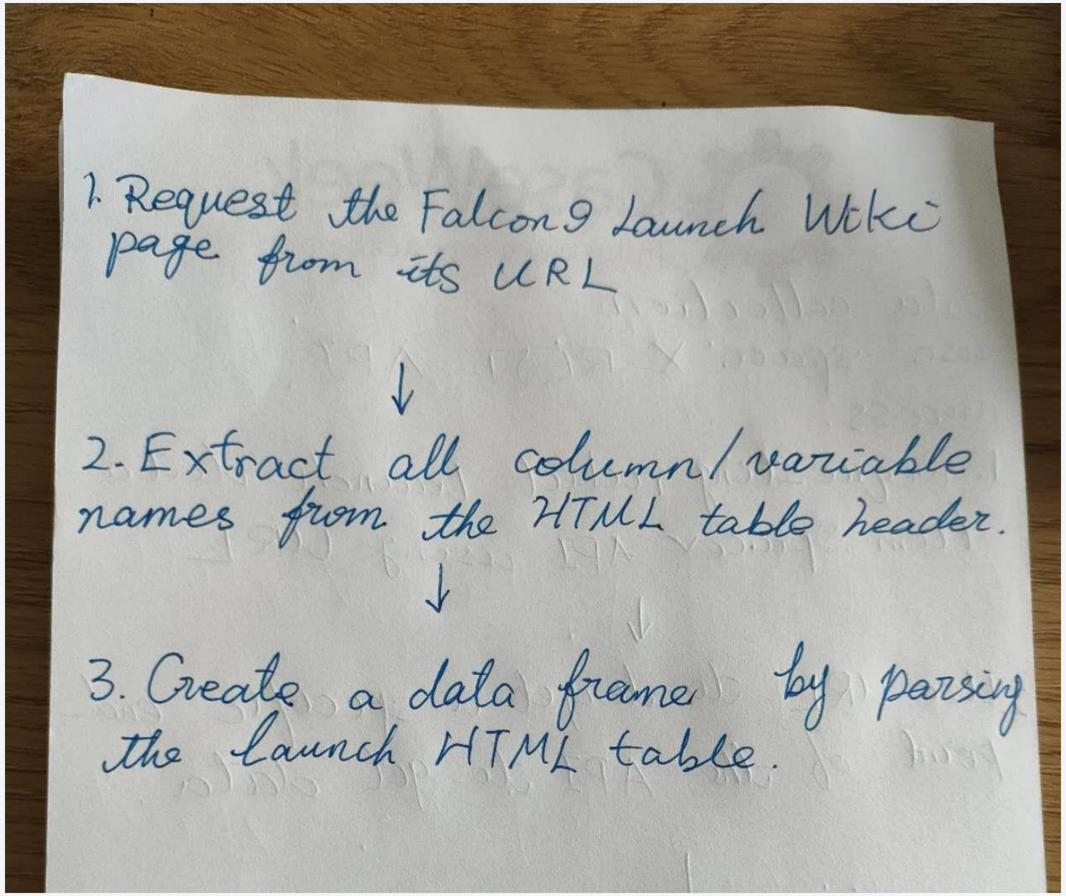


Data Collection - Scraping

- General flowchart is shown as right figure.

- The GitHub URL of the completed web scraping

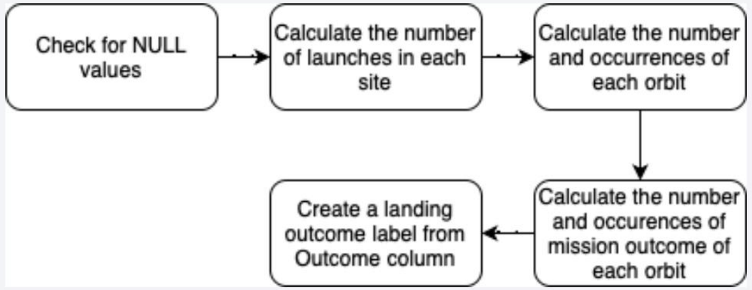
https://github.com/Urysohnish/Data-Science/blob/main/final_pro_datacollection_scri.ipynb



Data Wrangling

- General process of Data Wrangling:

1. Using isnull().sum() to fix the positions of missing data.
2. Using appropriate method to deal each missing value, such as adding the missing values as the average of the nearby values.
3. .replace() function to replace np.nan values in the data with the mean you calculated.



- The GitHub URL of completed data wrangling related notebooks, as an external reference and peer-review purpose:
- https://github.com/Urysohnish/Data-Science/blob/main/labs-jupyter-spacex-Data%20wrangling.ipynb

EDA with Data Visualization

- Summarize what charts were plotted and why you used those charts:

Bar chart

Line chart

Pie chart etc.

- The GitHub URL of your completed EDA with data visualization notebook, as an external reference and peer-review purpose:
- https://github.com/Urysohnish/Data-Science/blob/main/final2.2.ipynb

EDA with SQL

- Using bullet point format, summarize the SQL queries you performed:

Select

Group by

Order by

Distinct() etc.

- The GitHub URL of your completed EDA with SQL notebook, as an external reference and peer-review purpose:

https://github.com/Urysohnish/Data-Science/blob/main/jupyter-labs-eda-sql-final2.4.ipynb

Build an Interactive Map with Folium

- In the map, I created and added o markers, circles, lines.

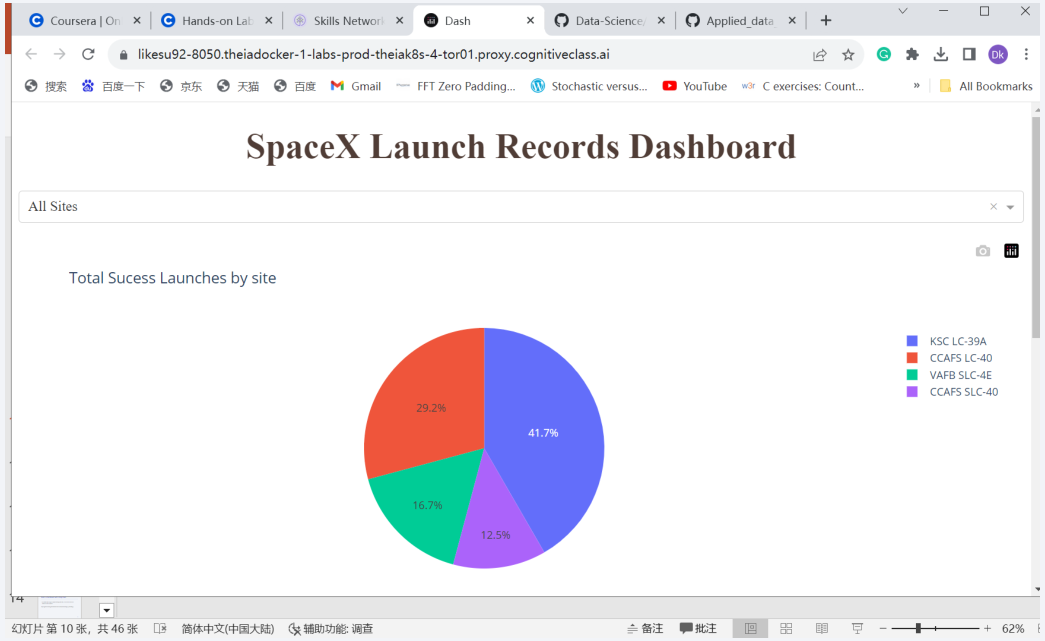
- The GitHub URL of your completed interactive map with Folium map, as an external reference and peer-review purpose:

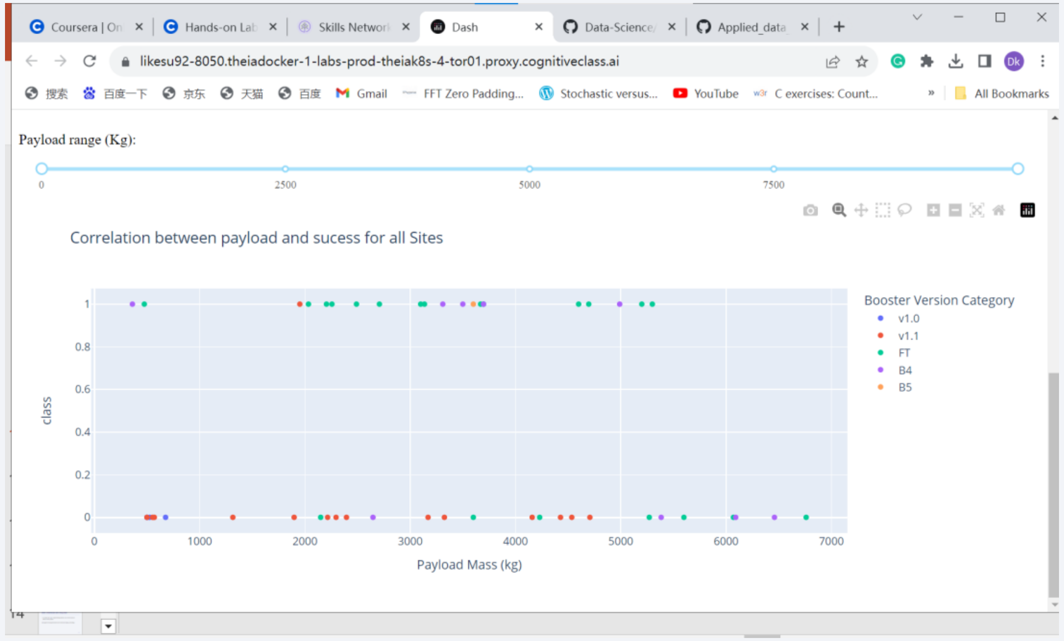
- https://github.com/Urysohnish/Data-Science/blob/main/IBM-DS0321EN-SkillsNetwork_labs_module_3_lab_jupyter_launch_site_location.jupyterlite.ipynb

Build a Dashboard with Plotly Dash

- The GitHub URL of your completed Plotly Dash lab, as an external reference and peer-review purpose:

https://github.com/Urysohnish/Data-Science/blob/main/final_project_dashboard.py





Predictive Analysis (Classification)

- Summarize how you built, evaluated, improved, and found the best performing classification model:

We split the data set into test set and training set. Built the different models and train the model on training set. Then get result on test set.

- The GitHub URL of your completed predictive analysis lab, as an external reference and peer-review purpose:

https://github.com/Urysohnish/Data-Science/blob/main/ai.ipynb

Results

- Exploratory data analysis results
- Interactive analytics demo in screenshots
- Predictive analysis results

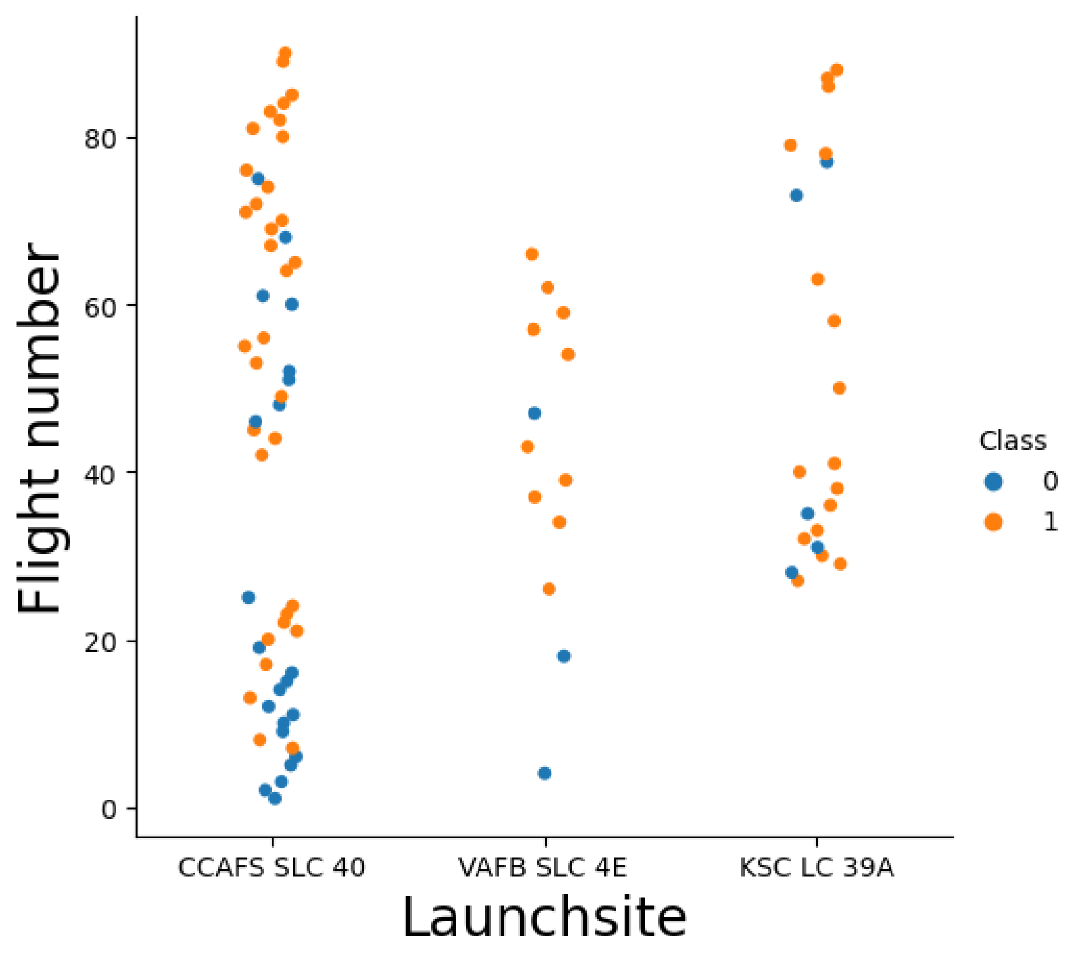
Section 2

Insights drawn from EDA

Flight Number vs. Launch Site

- The scatter plot of Flight Number vs. Launch Site

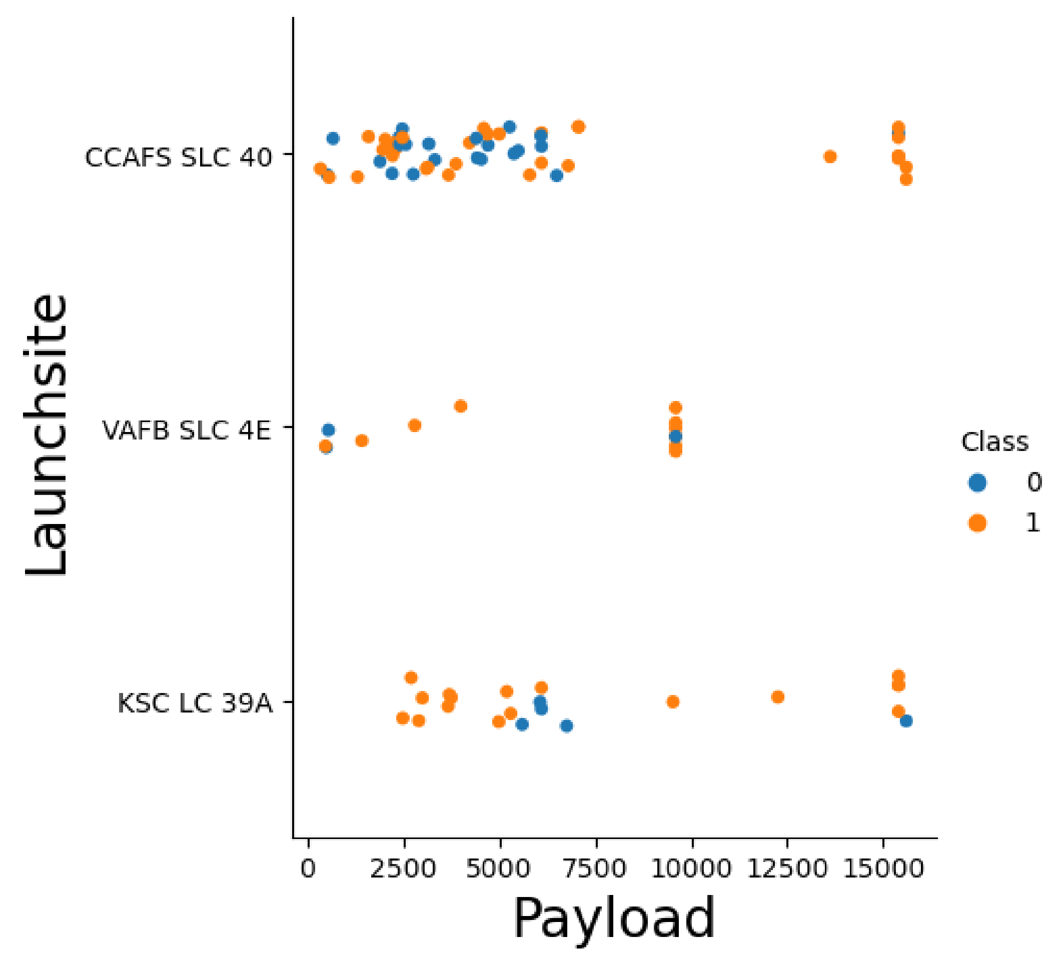
The totally lauching number in lauch site CCAFS SLC 40 is the greatest. The successful launching rate in launch site is the highest.



Payload vs. Launch Site

- The scatter plot of Payload vs. Launch Site

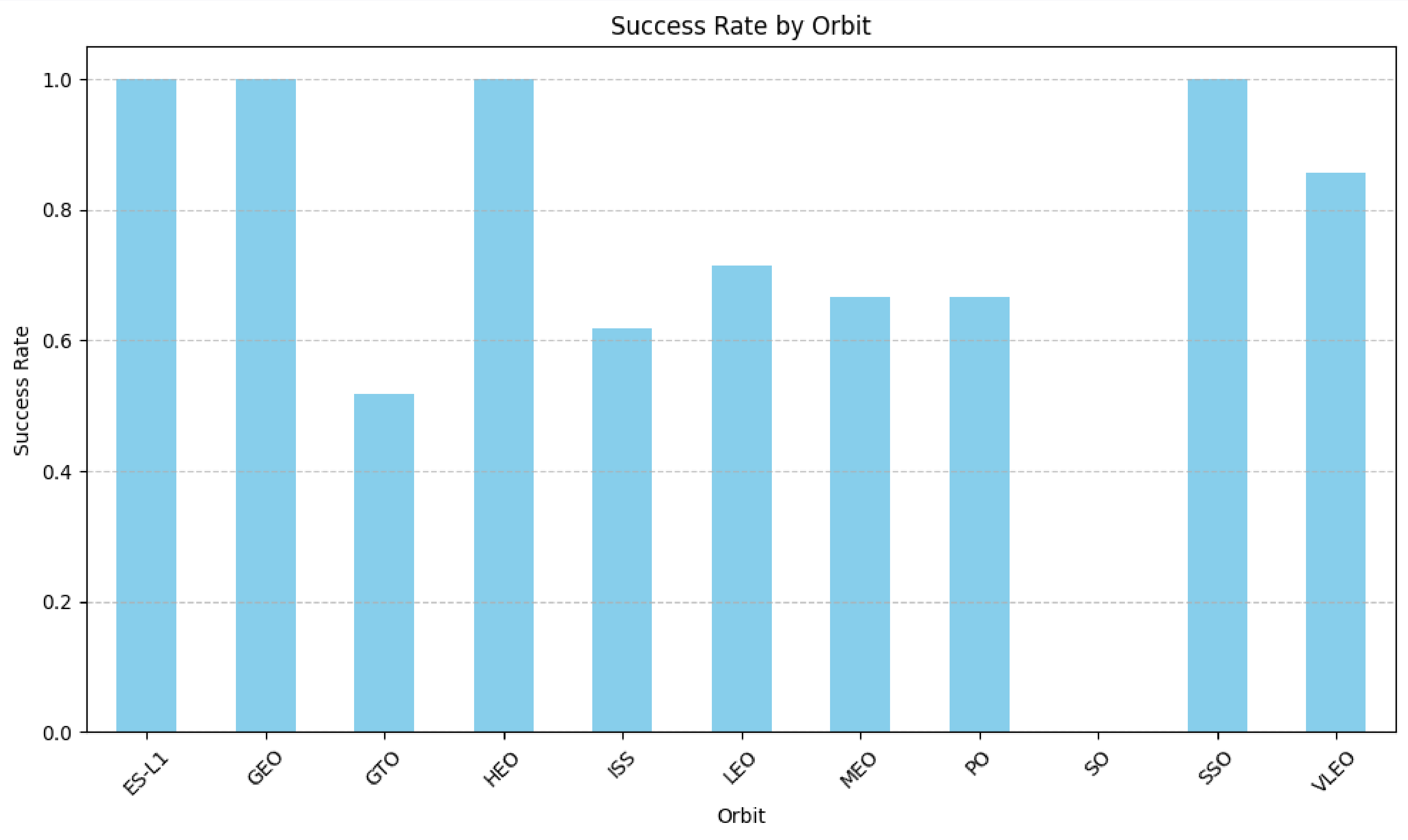
For payload above 10000 in launch site CCAFS SLC 40 the successful rate is approaching 100%.



Success Rate vs. Orbit Type

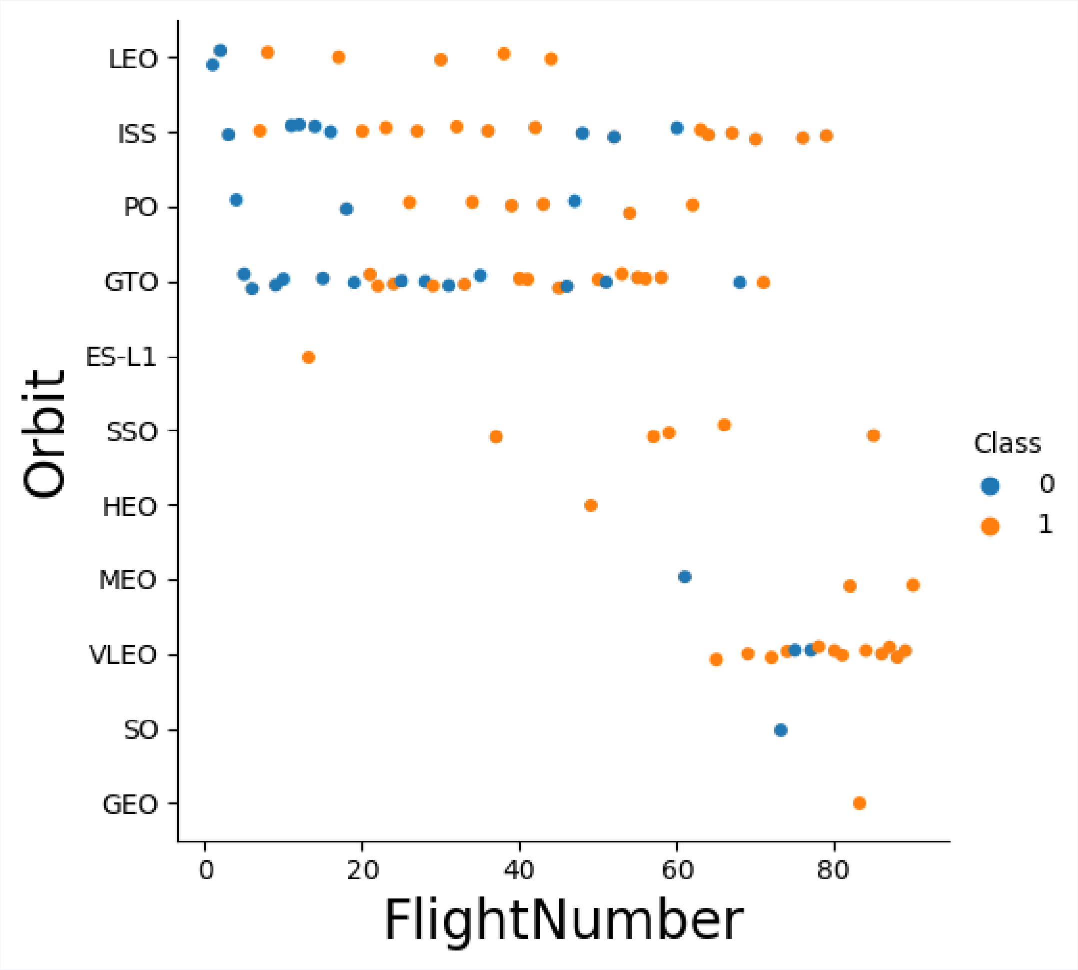
- The a bar chart for the success rate of each orbit type

- For four orbit type ES-LI, GEO, HEO, SSO, the successful launching rates are 100%.



Flight Number vs. Orbit Type

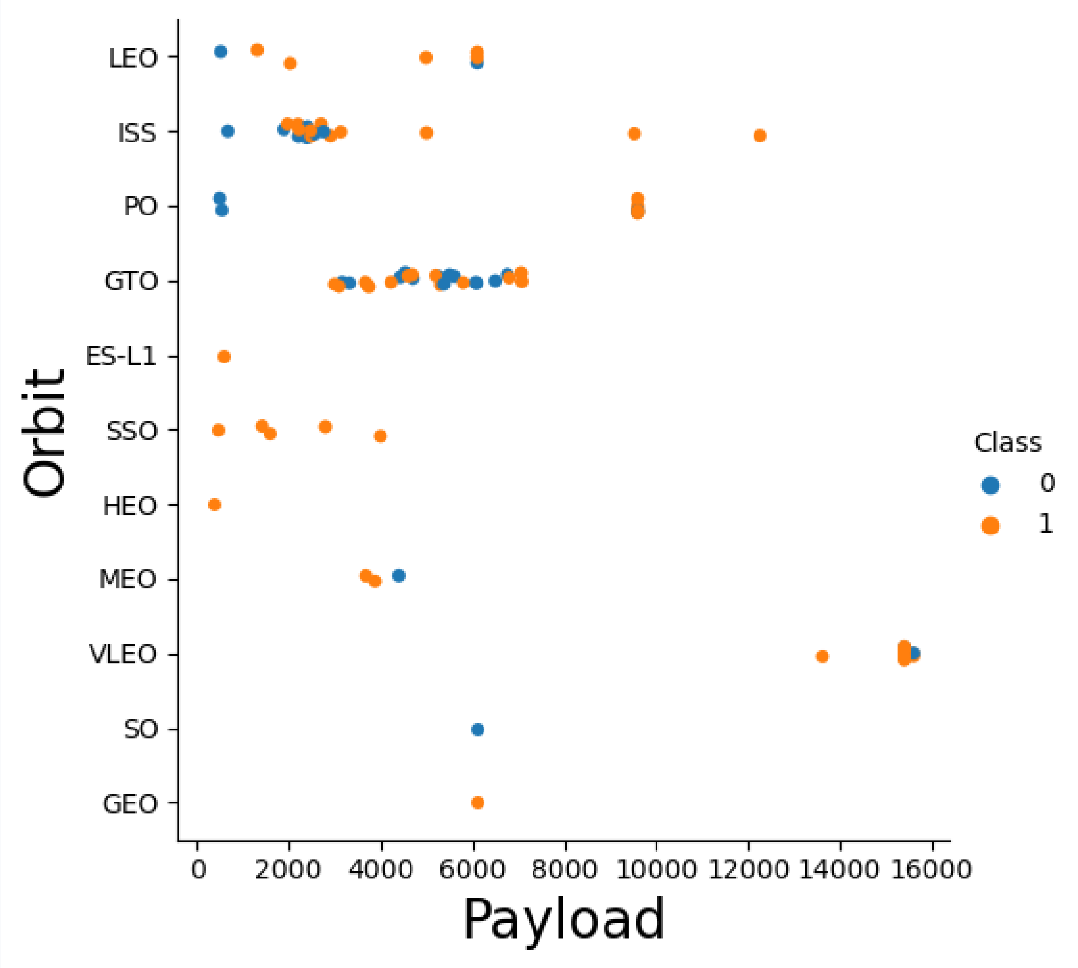
- The scatter point of Flight number vs. Orbit type
- Generally as the number of the flights increasing, there are more possible that the launching in each orbit is success.



Payload vs. Orbit Type

- The scatter point of payload vs. orbit type

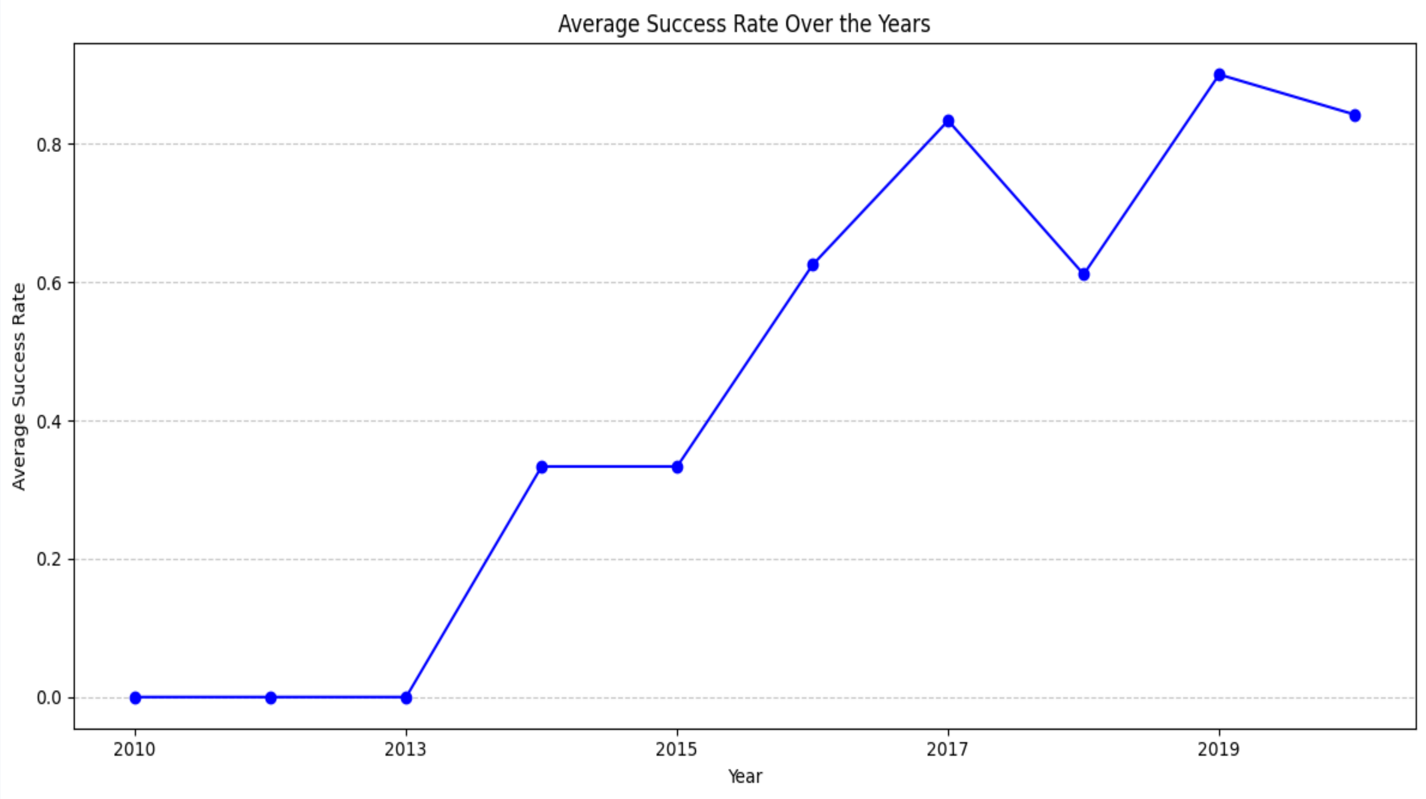
- For orbit ES-L1, SSO, HEO, no matter what value the payload is the success launching rate is always 100%.



Launch Success Yearly Trend

- The line chart of yearly average success rate

- Generally as the time increasing the success launching rate is raising, though there is a small fluctuation in year 2017-2019.



All Launch Site Names

- Find the names of the unique launch sites

Display the names of the unique launch sites in the space mission

```
[15]: %sql select distinct(Launch_Site) from SPACEXTABLE
```

```
 * sqlite:///my_data1.db
Done.
```

[15]:

Launch_Site
CCAFS LC-40
VAFB SLC-4E
KSC LC-39A
CCAFS SLC-40

Launch Site Names Begin with 'CCA'

- Find 5 records where launch sites begin with `CCA`

```
In [24]:  %sql select * from SPACEXTABLE where LauNch_Site LIKE 'CCA%' limit 5;

 * sqlite:///my_data1.db
Done.
```

Out[24]:

Date	Time (UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG_	Orbit	Customer	Mission_Outcome	Landing
2010-04-06	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success	Failure
2010-08-12	15:43:00	F9 v1.0 B0004	CCAFS LC-40	Dragon demo flight C1, two CubeSats, barrel of Brouere cheese	0	LEO (ISS)	NASA (COTS) NRO	Success	Failure
2012-05-22	07:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)	NASA (COTS)	Success	
2012-08-10	00:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)	NASA (CRS)	Success	
2013-01-03	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)	NASA (CRS)	Success	

Total Payload Mass

- Calculate the total payload carried by boosters from NASA
- The total sum is 45596KG.

Task 3

Display the total payload mass carried by boosters launched by NASA (CRS)

```
[47]: %sql select sum(PAYLOAD_MASS__KG_ )from SPACEXTABLE where Customer = 'NASA (CRS)'
```

```
 * sqlite:///my_data1.db
Done.
```

[47]:

sum(PAYLOAD_MASS__KG_)
45596

Average Payload Mass by F9 v1.1

- Calculate the average payload mass carried by booster version F9 v1.1

Task 4

Display average payload mass carried by booster version F9 v1.1

```
[38]: %sql select avg(PAYLOAD_MASS__KG_) from SPACEXTABLE where Booster_version Like 'F9 V1.1%'
```

```
 * sqlite:///my_data1.db
Done.
```

[38]:

avg(PAYLOAD_MASS__KG_)
2534.6666666666665

First Successful Ground Landing Date

- Find the dates of the first successful landing outcome on ground pad

Task 5

List the date when the first succesful landing outcome in ground pad was acheived.

Hint:Use min function

```
[39]: %sql select min(Date) from SPACEXTABLE where Mission_Outcome = 'Success'
```

```
 * sqlite:///my_data1.db
Done.
```

[39]:

min(Date)
2010-04-06

Successful Drone Ship Landing with Payload between 4000 and 6000

- List the names of boosters which have successfully landed on drone ship and had payload mass greater than 4000 but less than 6000

Task 6

List the names of the boosters which have success in drone ship and have payload mass greater than 4000 but less than 6000

```
[48]: ıere Landing_Outcome = 'Success (drone ship)' and (PAYLOAD_MASS__KG_ BETWEEN 4000 AND 6000)
```

```
 * sqlite:///my_data1.db
Done.
```

[48]:

Booster_Version
F9 FT B1022
F9 FT B1026
F9 FT B1021.2
F9 FT B1031.2

Total Number of Successful and Failure Mission Outcomes

- Calculate the total number of successful and failure mission outcomes

```
[41]: %sql select count(*) from SPACEXTABLE where Mission_Outcome = 'Success'

 * sqlite:///my_data1.db
Done.
```

[41]:

count(*)
98

```
[44]: %sql select count(*) from SPACEXTABLE where Mission_Outcome Like 'Failure%'

 * sqlite:///my_data1.db
Done.
```

[44]:

count(*)
1

Boosters Carried Maximum Payload

- List the names of the booster which have carried the maximum payload mass

```
[46]: %sql select booster_version from SPACEXTABLE where PAYLOAD_MASS__KG_= (select max(PAYLOAD_I
```

```
 * sqlite:///my_data1.db
Done.
```

[46]:

Booster_Version
F9 B5 B1048.4
F9 B5 B1049.4
F9 B5 B1051.3
F9 B5 B1056.4
F9 B5 B1048.5
F9 B5 B1051.4
F9 B5 B1049.5
F9 B5 B1060.2
F9 B5 B1058.3
F9 B5 B1051.6

LILI

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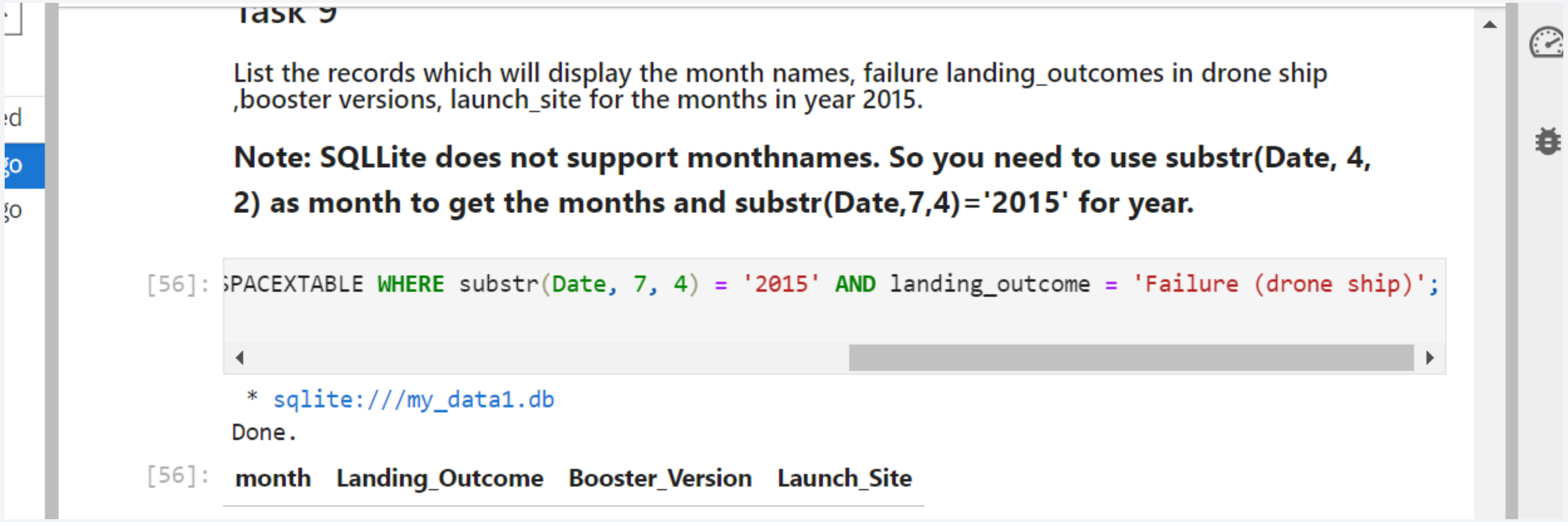
2015 Launch Records

- List the failed landing_outcomes in drone ship, their booster versions, and launch site names for in year 2015



Rank Landing Outcomes Between 2010-06-04 and 2017-03-20

- Rank the count of landing outcomes (such as Failure (drone ship) or Success (ground pad)) between the date 2010-06-04 and 2017-03-20, in descending order

```
[54]: %sql select Landing_Outcome, COUNT(*) as count FROM SPACEXTABLE WHERE Date BETWEEN '2010-0
```

```
 * sqlite:///my_data1.db
Done.
```

[54]:

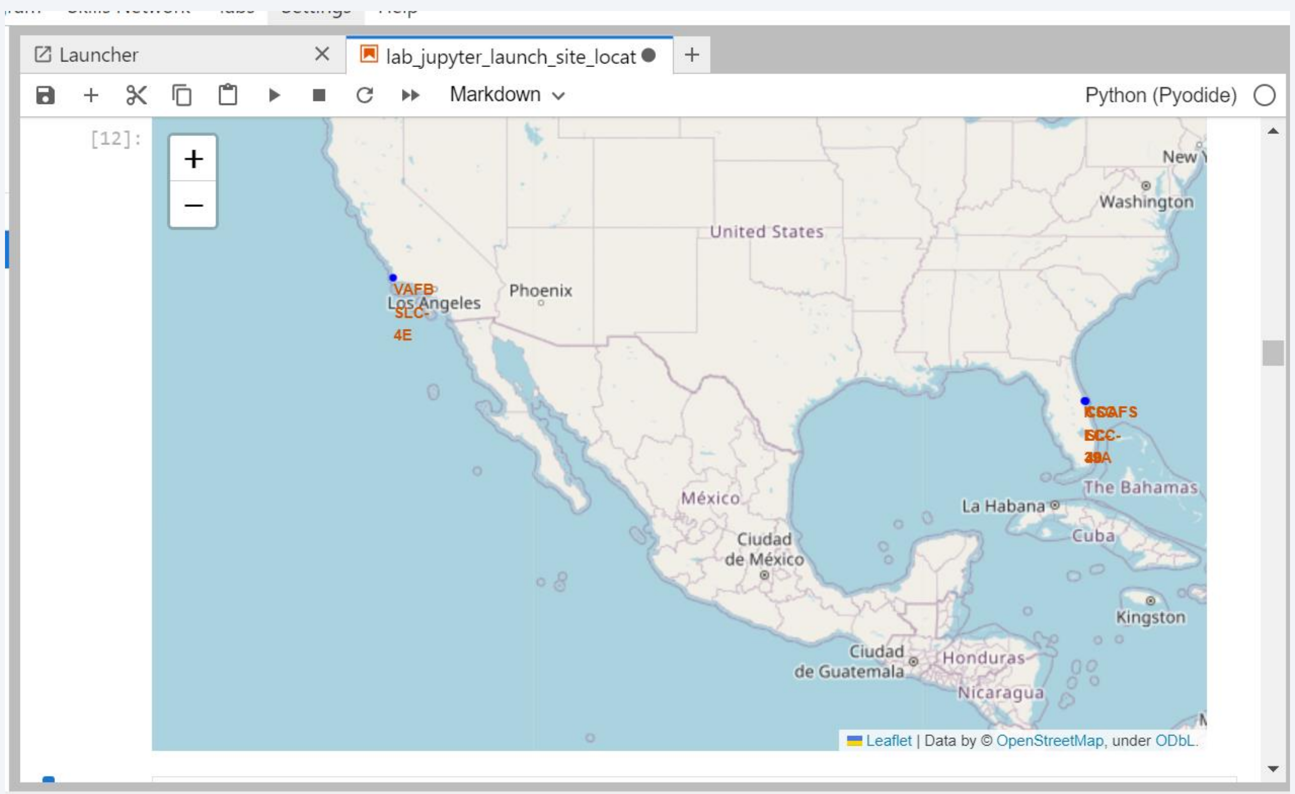
Landing_Outcome	count
No attempt	10
Success (ground pad)	5
Success (drone ship)	5
Failure (drone ship)	5
Controlled (ocean)	3
Uncontrolled (ocean)	2
Precluded (drone ship)	1
Failure (parachute)	1

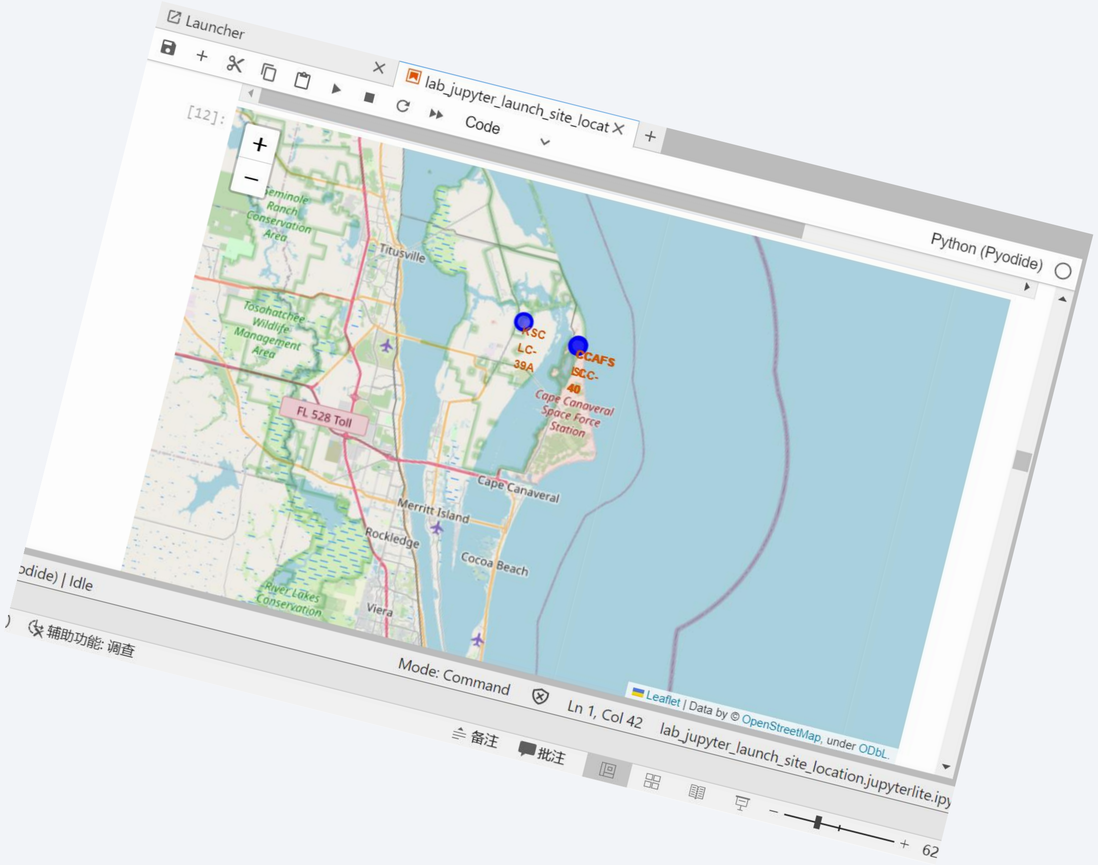
Reference Links

Section 3

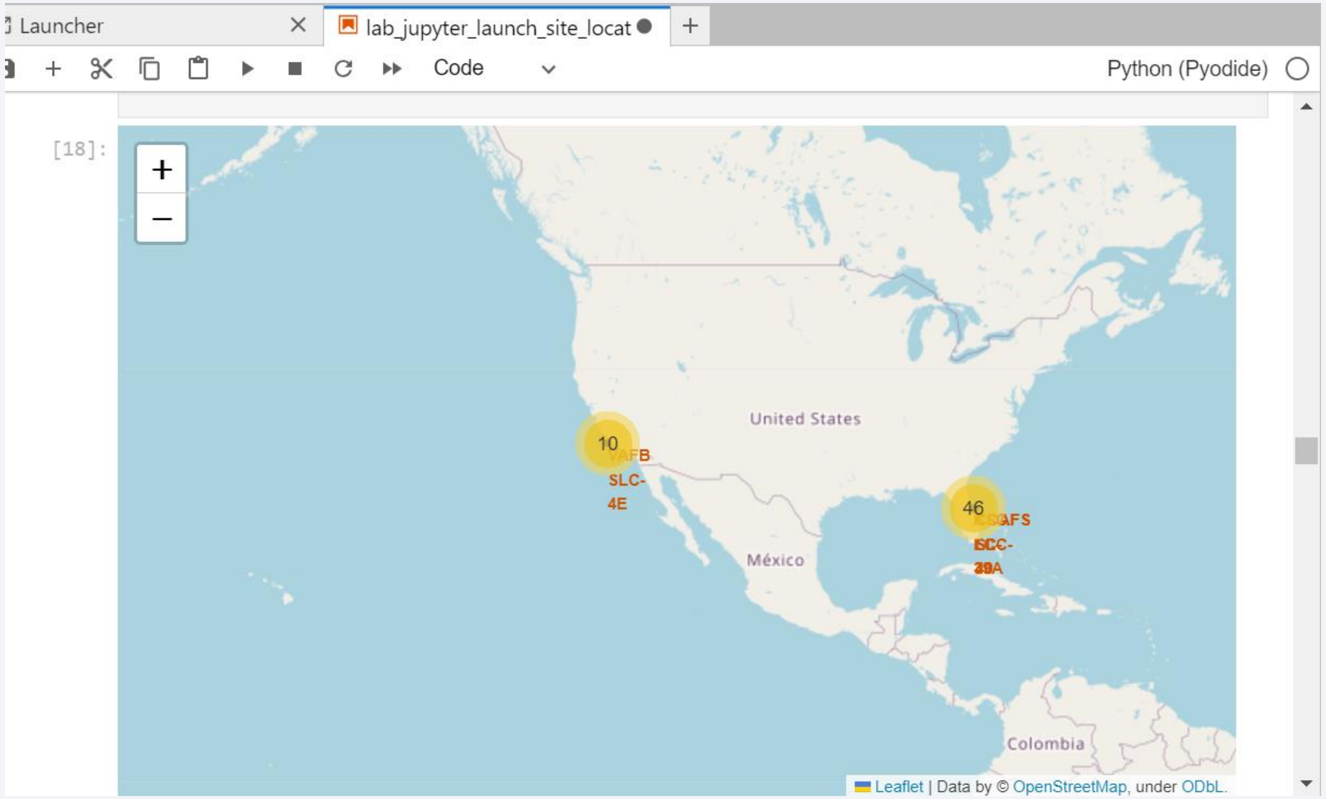
Launch Sites Proximities Analysis

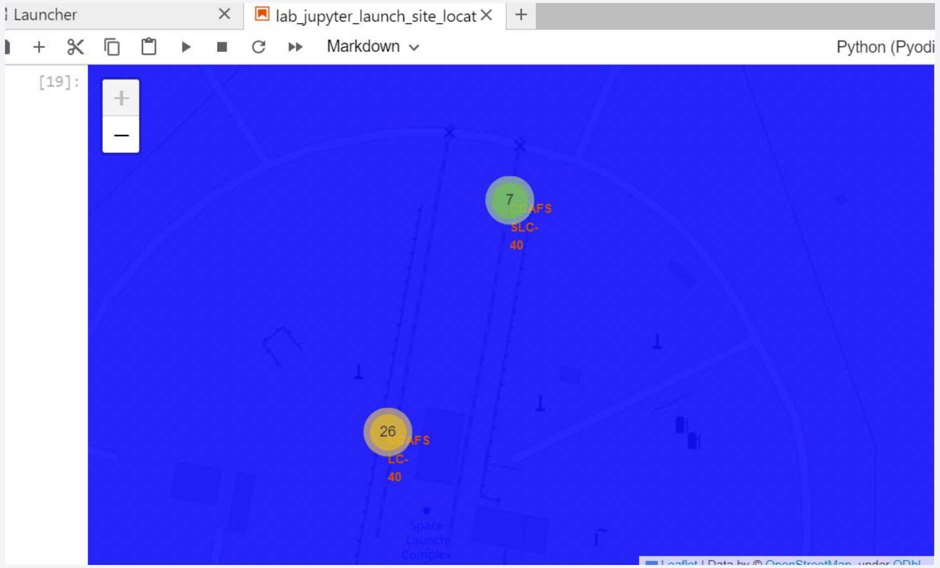
Mark all launch sites on a map



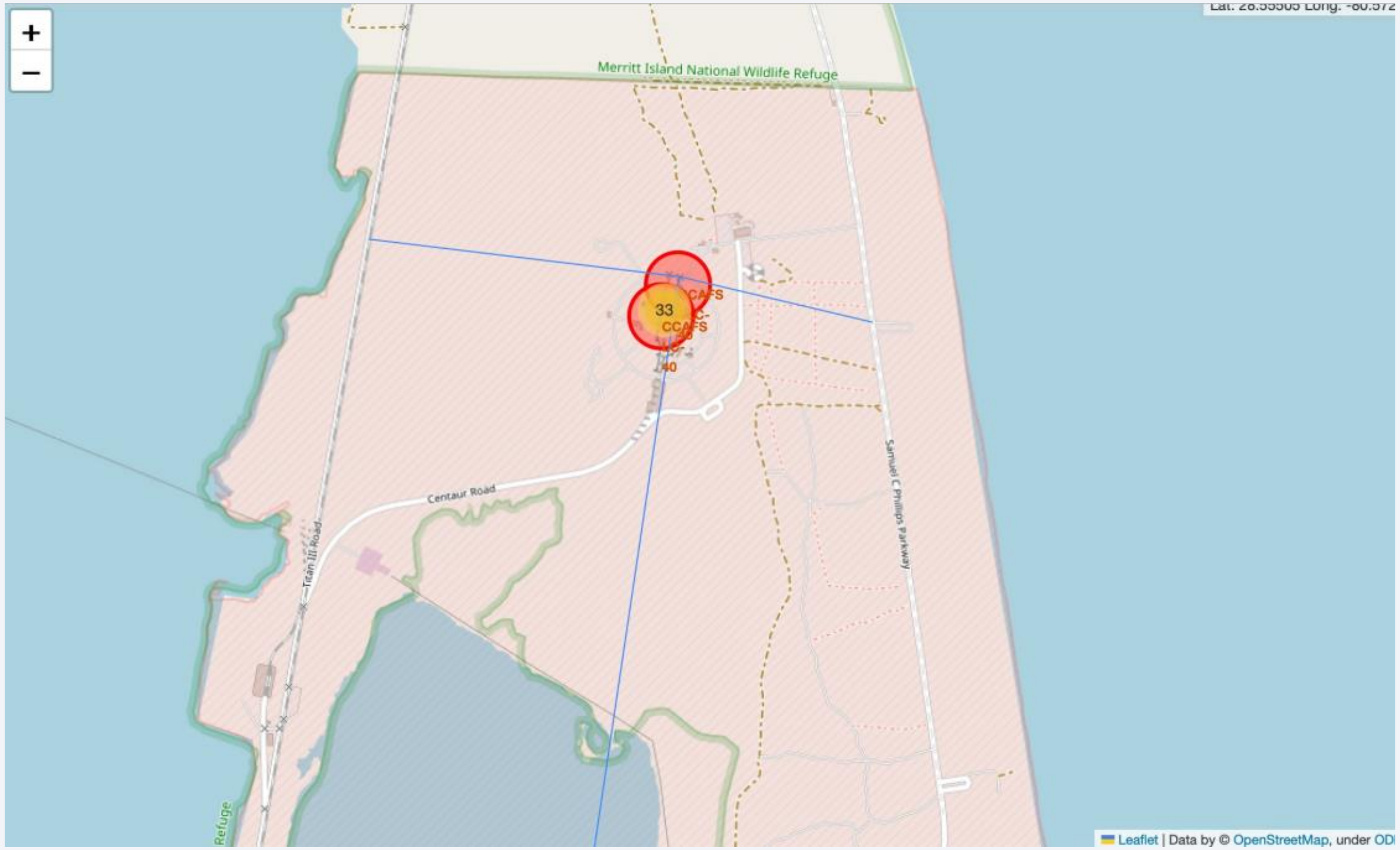


Mark the success/failed launches for each site on the map





Calculate the distances between a launch site to its proximities

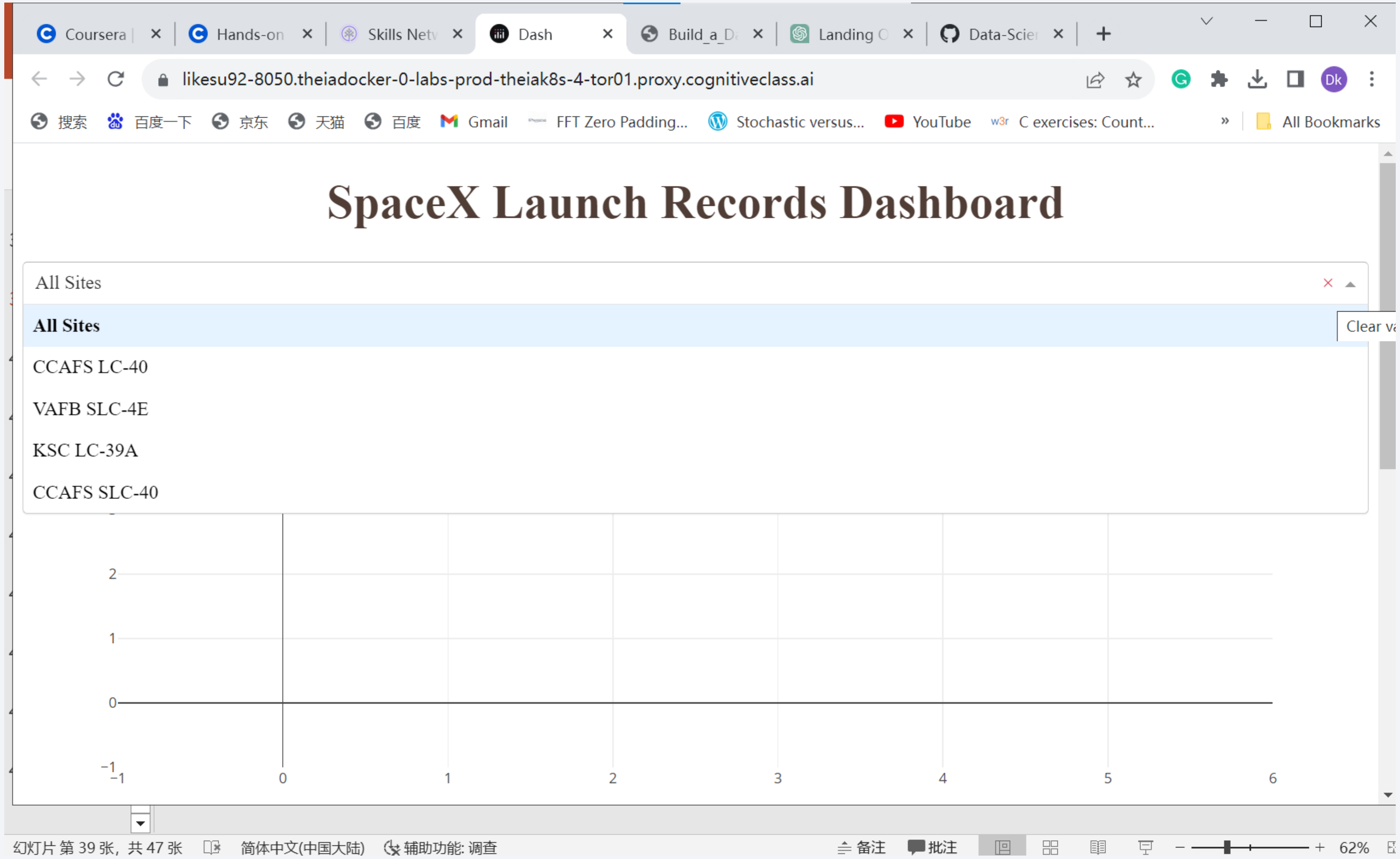


In the map, the blue line from the launch site to its nearest proximities.

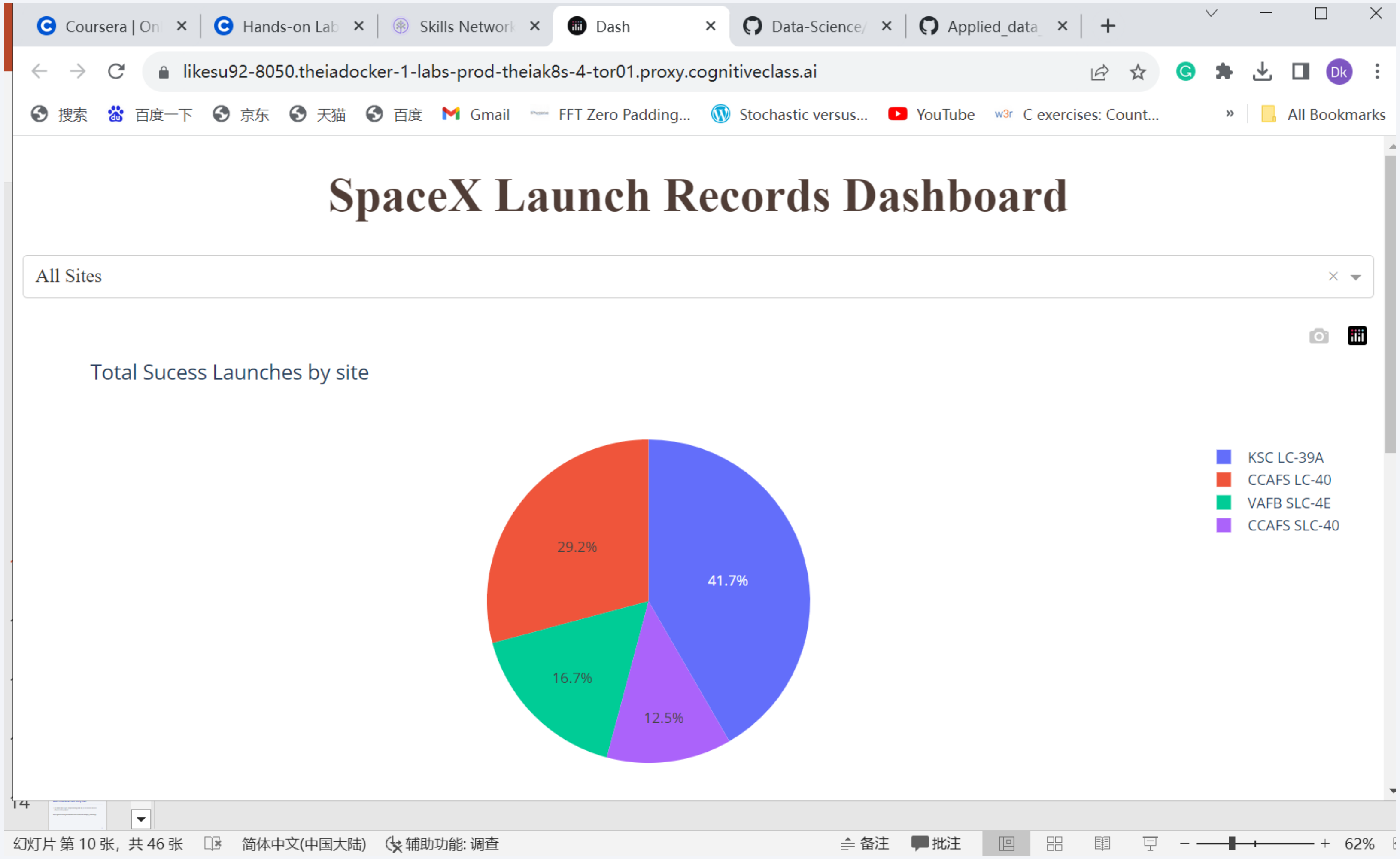
Section 4

Build a Dashboard with Plotly Dash

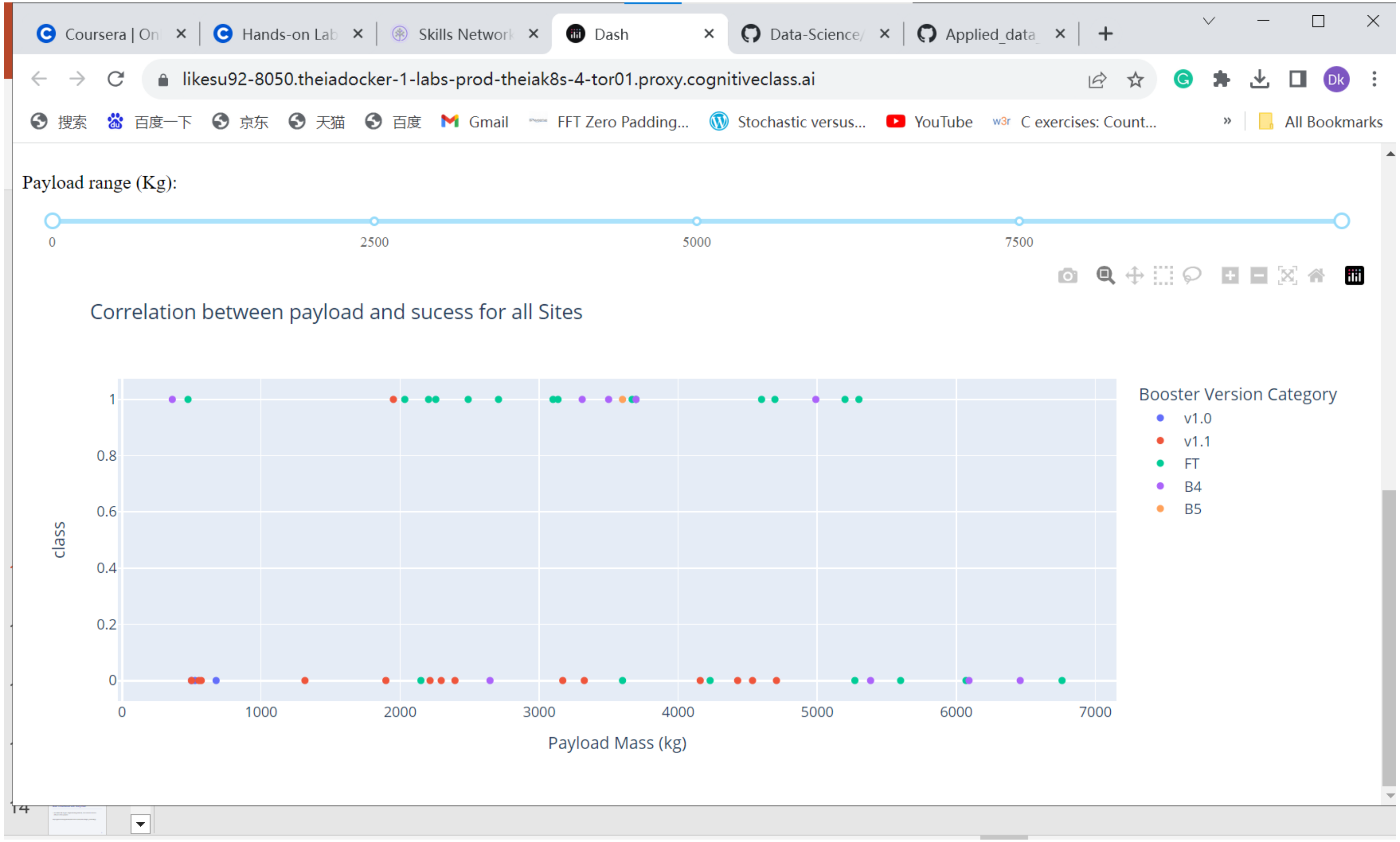
Add a dropdown list to enable Launch Site selection



Add a pie chart to show the total successful launches count for all sites



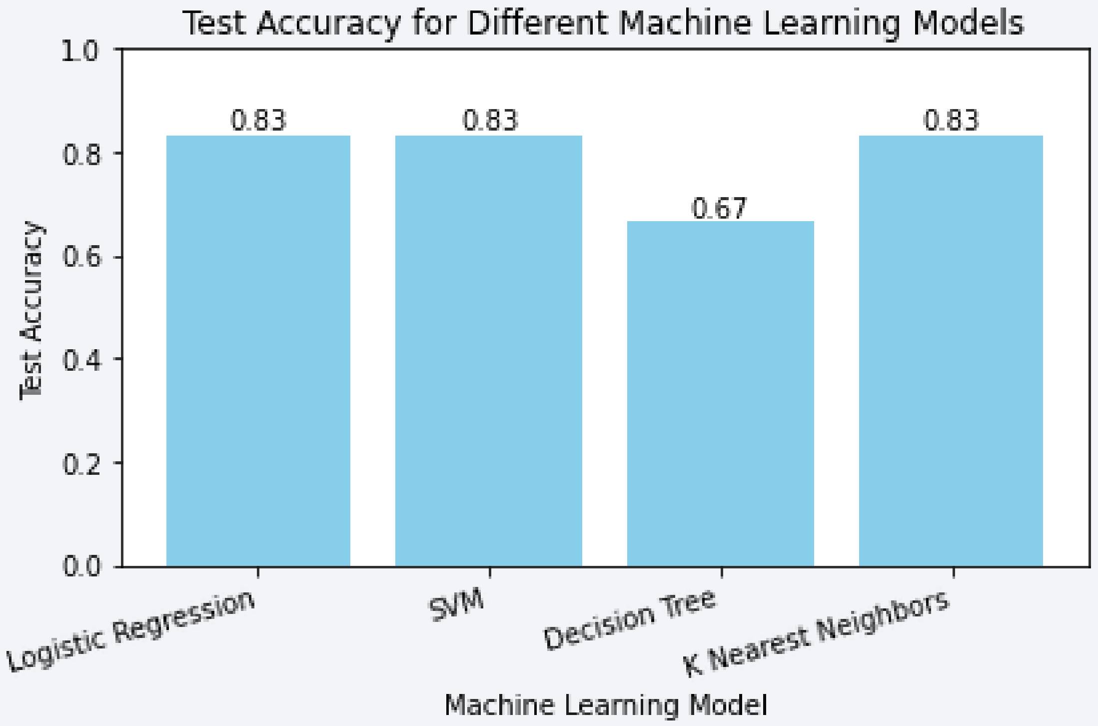
Landing outcome vs Payload mass



Section 5

Predictive Analysis (Classification)

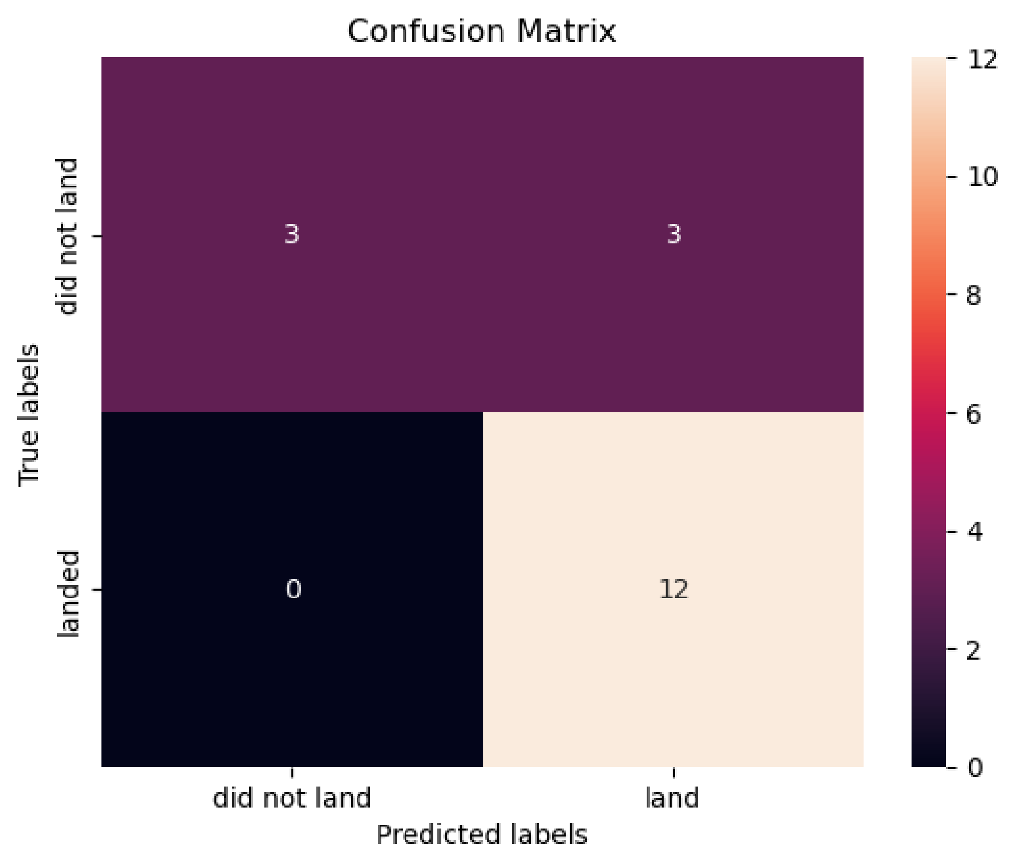
Classification Accuracy



- The models Logistic Regression, SVM, K nearest neighbors have the highest classification accuracy.

Confusion Matrix

The best performing model are K Nearest Neighbors , SVM and Logistic Regression, they all have the same accuracy and same confusion matrix.



Conclusions

- Point 1

In these three top models, we could see the successful landing rate is very high, almost 80%.

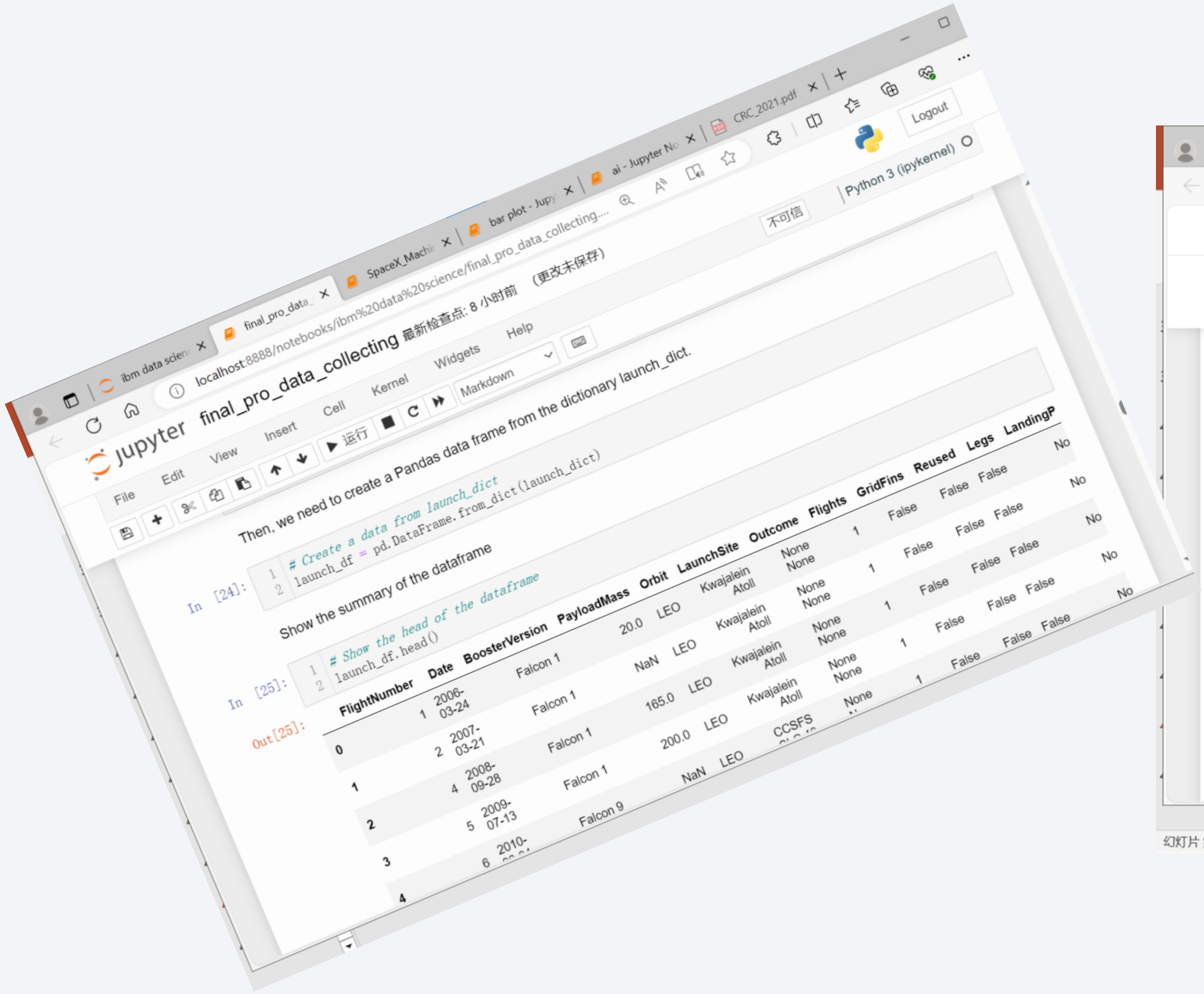
- Point 2

Successful landing rate is highly connected with the orbit type. Four orbit type ES-LI, GEO, HEO, SSO are among the perfact ones.

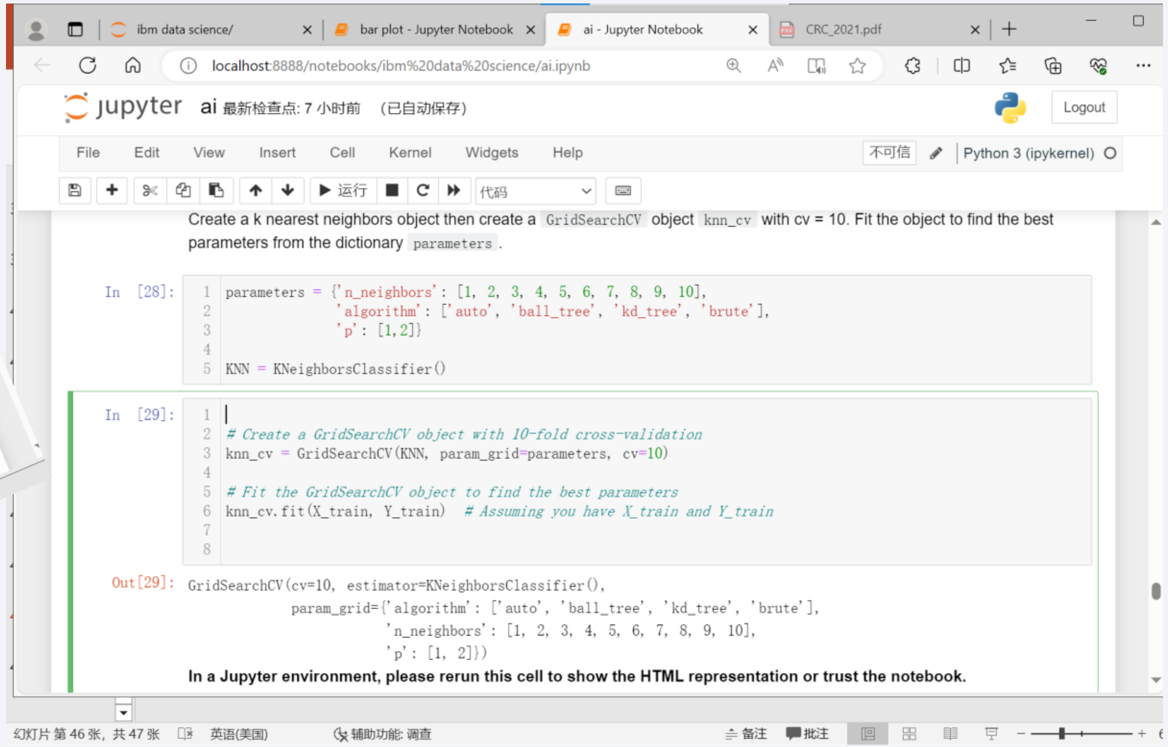
- Point 3

Successful landing rate is also highly connected with the place of submission. VAFB SLC 4E and KSC LC 39A have relatively high successful rate.

Appendix



jupyter final_pro_data_collecting 最新检查点: 8 小时前 (更改未保存)
Then, we need to create a Pandas data frame from the dictionary launch_dict.
# Create a data from launch_dict
launch_df = pd.DataFrame.from_dict(launch_dict)
Show the summary of the dataframe
# Show the head of the dataframe
launch_df.head()
FlightNumber Date BoosterVersion PayloadMass Orbit LaunchSite Outcome Flights GridFins Reused Legs LandingP



jupyter ai 最新检查点: 7 小时前 (已自动保存)
Create a k nearest neighbors object then create a GridSearchCV object knn_cv with cv = 10. Fit the object to find the best parameters from the dictionary parameters.
In [28]:
parameters = {'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
'p': [1,2]}
KNN = KNeighborsClassifier()
In [29]:
# Create a GridSearchCV object with 10-fold cross-validation
knn_cv = GridSearchCV(KNN, param_grid=parameters, cv=10)
# Fit the GridSearchCV object to find the best parameters
knn_cv.fit(X_train, Y_train) # Assuming you have X_train and Y_train
Out[29]: GridSearchCV(cv=10, estimator=KNeighborsClassifier(),
param_grid={'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
'p': [1, 2]})
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.

Thank you!